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AUTHOR Norton, John
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ABSTRACT

A brief resume of a major study conducted in 1973 identifies the extent to which the indigenous building methods and materials of Oman are capable of meeting the country's contemporary shelter needs, and compares them with alternative materials and techniques being introduced as replacements. Visits to 20 towns and villages in 6 regions and examination of local climatological data indicate that no one unified type of building can realistically be applied to the whole country. Unfortunately, evidence indicates that in 1973 a unified approach was being taken, with identical new building, using concrete block and sheet metal construction, occurring in different areas. Local materials (palm frond stems, mud bricks, limestone) and techniques (screens, lattice work, louvres, windcatchers, central courtyards) appear capable of meeting many local requirements, providing comfortable and healthy living conditions, adaptation to suit individual needs, and generating and stimulating the local economy. Indigenous methods suffer most from being associated with underdevelopment and the notion of being inferior to newly introduced solutions. New projects tend to employ foreign labor, skills, and materials. The use of new, imported techniques should be applied selectively and not as an overall approach, destroying the existing fabric of the country. (NEC)

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OMAN: Acase study on:

RESEARCH AND DEVELOPMENT OF THE INDIGENOUS BUILDING METHODS, MATERIALS, LOCAL SKILLS AND RESOURCES

by:

John Norton

Division of
Educational Policy
and Planning

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OMAN: A case study on:

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FOREWORD

Unesco's General Conference at its 19th session (Nairobi, Kenya, 1976) resolved that the Secretariat give particular attention to "gathering and disseminating information about new educational policies for the renewal of educational systems, adapted to specific needs on the basis of particular social, economic and cultural situations and aimed at promoting democratization of the systems within the framework of life-long education" (Programme Resolution 1.111).

In line with this mandate the Division of Educational Policy and Planning began in 1977 reproducing selected technical papers and distributing them as a series under the general title: "Reports, Studies ...". The aim of this series is to stimulate reflection and discussion on current issues confronting educational policy-makers, planners, administrators and school architects. Distribution is limited to Unesco officials at Headquarters and in the field, as well as interested technical personnel in governmental and private institutions. It is hoped that this series will promote and serve as a vehicle for increasing communication between individuals and institutions concerned with policy and planning aspects of education.

The "Reports, Studies ..." series consists of two sub-series :
(i) papers with a subject orientation (numbered S.1, S.2, etc.) and
(ii) papers focusing on a given country (numbered C.1, C.2, etc.).
Subject papers deal with such topics as educational policies and legislation planning and management techniques, planning and design of educational space and facilities, the relationship of education to productive work and employment, inter-country cooperation, the role of education in respect of the New International Economic Order, etc. Country papers are either brief profiles of the educational system of a particular country (mainly the LDCs) or treat a specific reform or aspect of the country's educational system.

Some of the papers reproduced in the series are "desk studies" based on information available within Unesco, others were originally prepared as background or discussion papers for a meeting or seminar, while still others are personal position papers representing part of a continuous dialogue within the Unesco Secretariat.

Papers are selected for the series on the basis of their topical interest. Readers should bear in mind that many, if not most, of the papers are working documents, unedited and not intended for public distribution. Some of the authors have written in a language other than their mother tongue, which explains certain linguistic deficiencies. It must also be stressed that the papers present the ideas of their respective author and do not necessarily reflect the policies of Unesco.

The Division of Educational Policy and Planning welcomes comments and suggestions concerning the series and invites readers to make known their reactions to particular ideas presented or to entire papers. In certain cases it may be possible to reproduce such comments and reactions in a subsequent issue of the series. For the convenience of readers who may wish to contact the author of a paper, the current contact address is given whenever possible.

AVANT PROPOS

La Conférence Générale de l'Unesco, lors de sa 19e session (Nairobi, Kenya, 1976) a décidé que "la collecte et la dissémination de l'information sur les nouvelles politiques d'éducation pour le renouvellement et la réforme des systèmes d'éducation adaptés aux besoins spécifiques basés sur des situations sociales, économiques et culturelles particulières et qui ont comme objectif la démocratisation des systèmes dans le cadre de l'éducation permanente" (Résolution 1.111 du programme) se situent parmi les objectifs prioritaires de l'Organisation.

Conformément à ce mandat, la Division des politiques et de la planification de l'éducation a entrepris en 1977 la reproduction et la distribution de certains documents techniques, sous le titre général de "Rapports et Etudes ...". Cette série a pour objet de stimuler la réflexion et les discussions portant sur les problèmes courants auxquels doivent faire face les décideurs, les planificateurs et les administrateurs de l'éducation ainsi que les architectes scolaires. La distribution se limite aux professionnels du Siège et hors-Siège, ainsi qu'aux personnels d'institutions gouvernementales ou privées susceptibles de les trouver utiles pour leur travail. Nous espérons que cette série constituera un moyen pour promouvoir et augmenter la communication entre les individus et les institutions concernés par les différents aspects des politiques et de la planification de l'éducation.

Ces "Rapports et Etudes ..." se divisent en deux catégories: (i) les documents qui traitent d'un sujet (numérotés S.1, S.2, etc.) et (ii) les documents qui traitent d'un pays (numérotés C.1, C.2, etc. Les premiers portent sur des sujets tels que les politiques et la législation de l'éducation, les techniques de gestion et de planification, la planification et l'étude des espaces, constructions et équipements éducatifs, la relation entre éducation/travail/emploi, la coopération entre les pays, le rôle de l'éducation par rapport au Nouvel ordre économique international, etc. Les seconds présentent des profils du système éducatif d'un pays donné (principalement les pays les moins développés), ou traitent d'une réforme ou d'un aspect spécifique du système éducatif du pays concerné.

Certains des documents reproduits dans cette série sont des "desk studies" basés sur des informations déjà existantes à l'Unesco, d'autres ont été préparés à l'origine pour servir de documents de base ou de discussion à des réunions ou séminaires, alors que d'autres encore, exprimant les positions personnelles des auteurs, se situent dans le cadre d'un dialogue permanent au sein du Secrétariat de l'Unesco.

Les documents sont choisis pour cette série en fonction de l'actualité du sujet traité. Les lecteurs doivent tenir compte du fait que beaucoup, sinon la plupart, des documents sont des documents de travail inédits et ne sont pas destinés au public. Certains auteurs ont rédigé ces documents dans une langue qui n'est pas la leur, ce qui explique certaines faiblesses linguistiques. Nous voudrions également souligner que les documents expriment les idées de leurs auteurs respectifs et ne reflètent pas nécessairement la politique de l'Unesco.

La Division des politiques et de la planification de l'éducation souhaite recevoir des commentaires ou suggestions au sujet de la série, et demande aux lecteurs de bien vouloir faire part de leurs réactions à certaines idées exprimées ou à des documents dans leur ensemble. Dans certains cas, il sera peut-être possible de reproduire ces commentaires et réactions lors d'une prochaine parution de la série. Les adresses des auteurs des documents sont indiquées afin de donner aux lecteurs qui le désirent la possibilité d'entrer en contact avec eux.

DEVELOPMENT WORKSHOP

The Development Workshop is a team of architects, planners and researchers from a number of countries who work collectively on the development of indigenous building and planning methods in the Third World. Projects have been undertaken in African, Middle Eastern and Asian countries. Members of the Workshop believe that appropriate solutions to human settlement problems can be developed from indigenous methods which have evolved from and remain in the hands of Third World communities. The Workshop works in the field of rural and urban human settlements. The development of small scale construction industries, technical training and local participation are integral to the Workshop's approach.

John Norton is a founder member of Development Workshop.

SUMMARY

This case study is a summary of research programmes conducted in Oman. The purpose of the research was to inform policy makers about the potentials and problems of indigenous building methods.

The case study outlines a methodology for assessing the problems and potentials of indigenous building methods. It shows how these can be used and developed to meet present shelter needs and how the problems that exist can be overcome without resorting to new, imported and expensive solutions, often beyond the financial range of the individuals in developing countries and frequently socially, culturally and environmentally inappropriate.

It should be noted that indigenous solutions are well suited to local conditions and that much can be learnt from the way in which they work.

The interesting experiences in appropriate technology described in this document have been in housing; it is being published so that readers may also find this approach useful in school construction.

RESUME

Cette étude de cas résume le programme de recherche qui a été entrepris à Oman dans le but d'informer les responsables chargés de promouvoir les politiques en matière de construction sur les possibilités offertes par l'utilisation des méthodes de construction indigènes ainsi que sur les problèmes qui y sont liés. Elle propose une méthodologie permettant de mettre en lumière ces problèmes et possibilités et définit de quelle manière les méthodes de construction locales peuvent être utilisées pour faire face aux besoins actuels et comment les problèmes existants peuvent être résolus sans avoir à recourir à des solutions nouvelles, impliquant des importations ou des coûts élevés qui vont souvent au delà des possibilités financières des individus dans les pays en développement et sont en général inappropriées d'un point de vue social et culturel et par rapport au respect de l'environnement.

En outre, l'étude souligne le fait que les solutions indigènes sont bien adaptées aux conditions locales et qu'en cherchant à comprendre leur essence, on peut enrichir la connaissance.

Des expériences intéressantes en matière de technologies appropriées, décrites dans ce document ont été pratiquées dans le domaine du logement. Ce document est publié dans le but de permettre au lecteur d'appliquer une telle approche aux constructions scolaires.

OMAN

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RESEARCH AND DEVELOPMENT OF INDIGENOUS BUILDING METHODS, MATERIALS, LOCAL SKILLS AND RESOURCES.

OMAN

This case study is a brief resumé of a major study carried out between September and November 1973, dealing with the problems and potentials of the Indigenous built environment of Oman.*1

The aim of the study was to identify, whilst the opportunity still existed, to what extent the indigenous building methods and materials that Oman possesses are capable of meeting the country's contemporary shelter needs. The study also aimed to identify what improvements were needed.

1 BACKGROUND

Prior to 1970 Oman had been isolated from the rest of the world. Before H.M. Sultan Qaboos took power in 1970 the country's development had been at a virtual standstill, to the extent that repairs to existing buildings were discouraged. Since 1970, there has been a general opening up in the development of the country. In 1973, at the time of this study, 2 characteristics were clear in the way that the country's built environment was being developed. Revenue from oil exports had made it possible for the Government to take an extremely westernised approach to building, and at the same time the indigenous building methods and materials were being discarded in favour of new, more prestigious materials and techniques. A statement made in the Whitehead Consulting Group's Economic survey of Oman 1972 *2 illustrates the direction

*1 CAIN, A; AFSHAR, F; NORTON, J. OMAN, The problems and potentials of the indigenous built environment in a developing country. London, by authors. 1975

*2 Whitehead Consulting Group. Economic Survey of Oman 1972 Muscat, Oman. Section 4. i.e. Environmental Sanitation.

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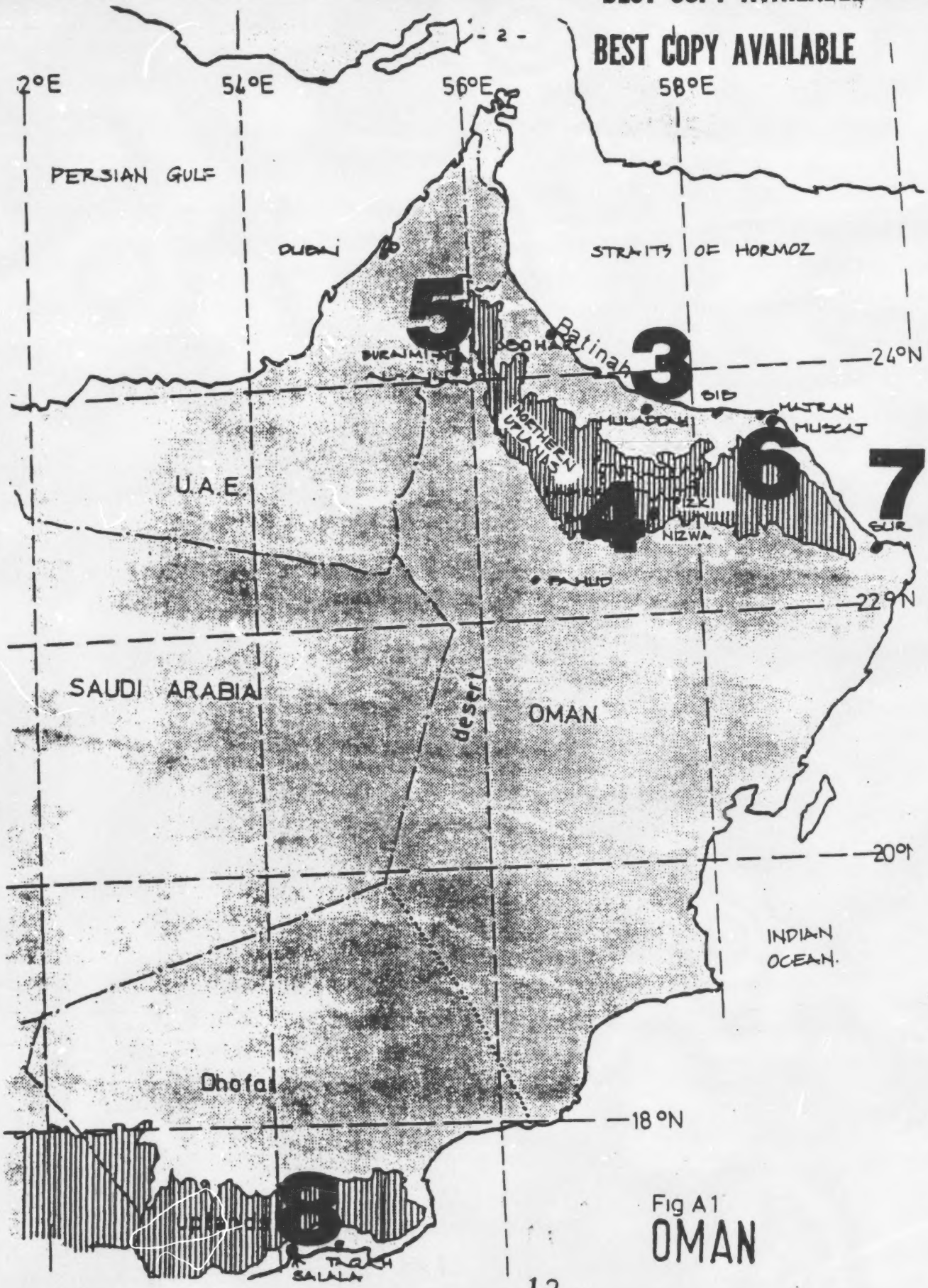


Fig A1
OMAN

that housing policy was taking. "Housing should provide protection against extremes of weather as well as privacy and facilities for a healthy way of life. This is certainly not provided by barasti and mud houses and to impose such standards here would be unrealistic."

Barasti (Palm frond stems) and mud were the two major building materials of the country, and the majority of Omanis lived in houses using these materials. It was felt by the study team that since the majority of Omanis live in these barasti and mud houses such a dismissal of their environment and its potentials was unfortunate, especially when no obvious alternative was economically or physically practical in the foreseeable future. No study had been undertaken to ascertain exactly how these materials functioned, nor to what extent they "provided protection against extremes of weather as well as privacy and facilities for a healthy way of life". *2

A focal point of the study was therefore to assess the performance of the indigenous built environment, and to compare it with the alternative materials and techniques being introduced as replacements.

It was hoped that through the report on Oman's indigenous built environment, an approach to the shelter needs of the country could be developed which would more readily meet the social, economic, environmental and cultural needs of the country. To make the best use of the country's resources it was necessary for policy makers to understand the potentials and problems that existed.

2 PROGRAMME

Whilst in Oman we visited and stayed in some 20 towns and villages in six of the eight major regions of the country.

The areas studied were:

3. The Northern Coastal Plain (Batinah Coast).
4. The Northern Uplands (Nizwa, Bahla, Izki).
5. The Buraimi Oasis.
6. The Capital Region (Muscat, Mutrah, Ruwi).
7. Sur (On the North East corner of Oman).
8. The Dhofar Coastal Plain (Salala). Fig. A.1.

Prior to starting the field work, as much documented material as possible was collected, covering two major items: any previously recorded information concerning the built environment; detailed information and statistics for the climate in all the areas to be visited.

The climatic data available was limited and in many cases the figures had been collected for a short period only, consequently reducing the accuracy of the overall averages. In every settlement visited, descriptions of the local climate, including any abnormalities which existed, were collected from villagers, To further supplement this information, readings were taken for temperature, relative humidity and wind speed and direction, using portable equipment. These readings were essential for gaining an understanding of the micro climate which affects individual settlements and buildings. This is extremely important since the climatic performance of a building, especially in situations with unfavourable climates, is inseparable from the provision of protection against extremes of weather and facilities for a healthy way of life. An understanding of the local climate enables one to see in what way the building must

respond to provide an internal climate within the comfort zone. *1

During the field work the team spent an average of two weeks in each area. (The Buraimi Oasis study was conducted over a period of 24 hours, because of difficulties in travelling to the oasis from the Capital Region). In each place visited, discussions were held with the local inhabitants and especially local builders. Through these discussions we gathered information about the way that buildings were used and how they responded to local needs and the climate. At the same time settlements and individual buildings were surveyed, to be drawn up later, and samples of local and imported building materials were collected for analysis. Most of the problems faced by the local population became apparent through these processes, as well as the advantages and disadvantages of the different types of buildings.

The following sections will deal briefly with each of the six areas visited.

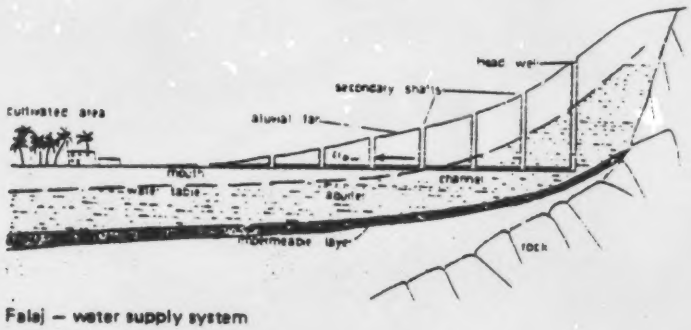
3 THE NORTHERN COASTAL PLAIN (BATINAH COAST)

3.1 Introduction

This is a strip of coastal plain facing the straits of Hormoz. It averages between 10 to 30 kms wide and stretches from the fontier with the United Arab Emirates in the North West, down to Azaiba, 270 kms to the South East. Along the coast is a 3 km wide strip of date palm gardens and cultivation, and most settlement occurs either at the

*1 The Comfort zone is a range of effective temperatures within which the human body performs most efficiently and comfortably.

edge or within this belt, inland of which is mostly scrubland with scattered acacia trees. In 1973 the local economy was still based upon two main items; dates and fish, with the majority of the population living near their place of occupation. The water supply, important in maintaining settlements in this area, comes from 2 sources, wells, which nowadays supply most of the water, and Falaj a system of underground and surface water channels which tap the water table up in the foothills and transport water by gravity down to the date gardens and settlements.*1 (Fig. A.2)



Falaj – water supply system

Fig A2

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*1 A system almost certainly introduced from Iran, where they are known as Qanat and have supplied the water for settlements throughout central Iran for centuries, and have been a major factor in the location of villages and towns.

The Batinah coast has a climate directly affected by its proximity to the sea. The high humidity and the sea's steady temperature have a moderating effect upon the temperature pattern, with an annual range of only 15°C and a diurnal range of 10°C. (Fig. A.3)

These ranges increase with distance from the sea as humidity drops. In general conditions are uncomfortably hot from May to September and uncomfortably cool between December and February. This pattern has a distinct influence upon the house forms of the area and the materials that they use.

A micro climatic comparison in Sohar, conducted over a 24 hour period (22 - 23 September 1973) shows the differences that exist between the beach front, a location in the date gardens and a location inland of the date garden. The built form and materials showed a clear response to this, especially when seen in terms of the range of climate over the year. The three locations are characteristic for the Batinah Coast. (Fig. A.4)

3.2 Beach Front house

High relative humidity and temperatures, with a low diurnal range make the introduction of air movement through the beach front buildings essential for comfort during the summer. Summer rooms are built facing the sea, hence orientated to make maximum use of onshore/offshore sea breezes. These rooms have walls made up as panels of palm frond stems with the leaves removed, supported by a timber, or more recently concrete framework. These screens perform various functions. a) They allow air to pass unrestricted through them: essential for comfort. b) They provide privacy: the darker interior cannot be looked into from bright conditions outside, and one focusses naturally upon the external surface of the screen.

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Fig A3

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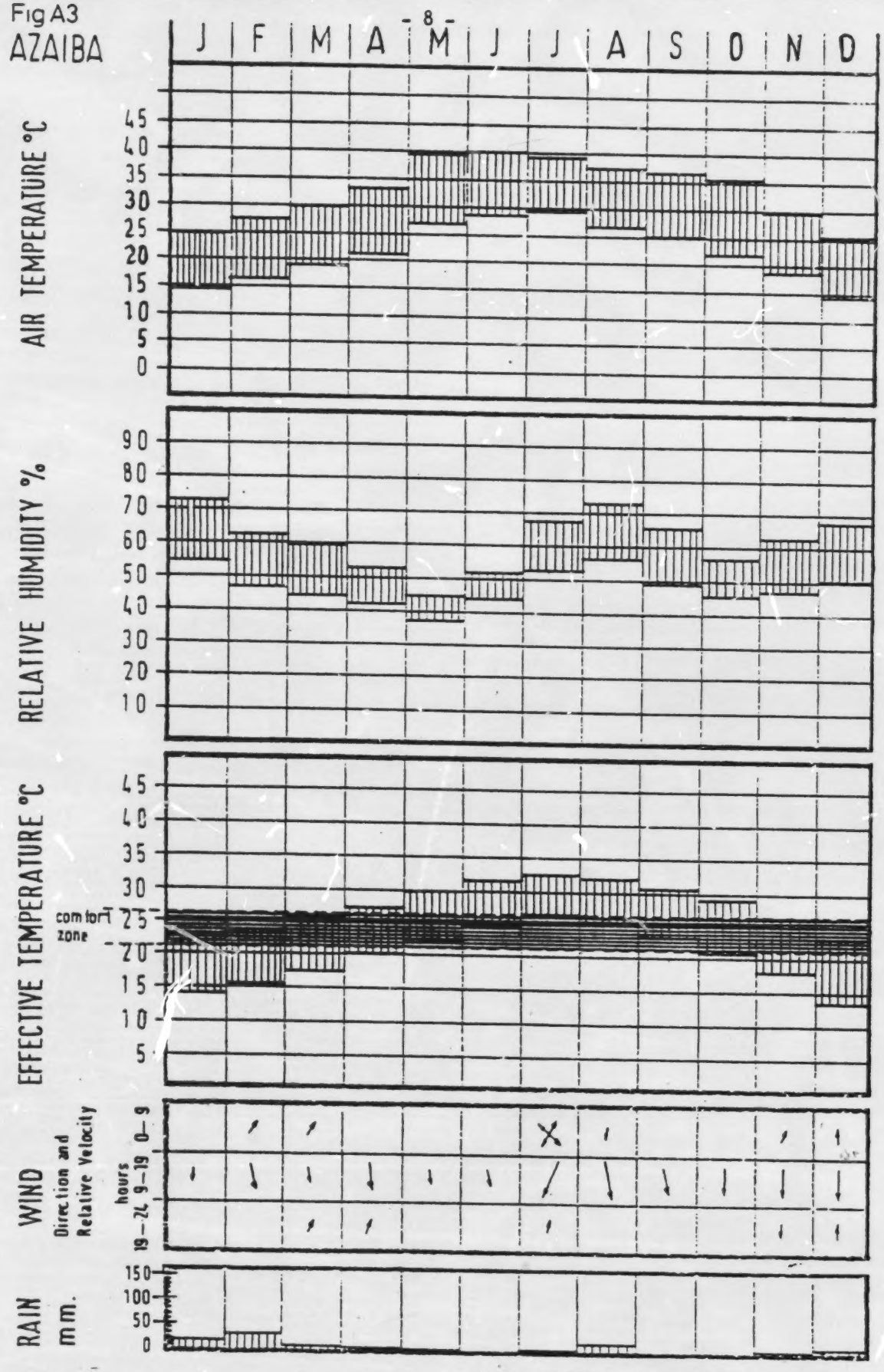
J F M A M J J A S O N D
AIR TEMPERATURE °C
45 40 35 30 25 20 15 10 5 0
RELATIVE HUMIDITY %
90 80 70 60 50 40 30 20 10
EFFECTIVE TEMPERATURE °C
45 40 35 30 25 20 15 10 5
comfort zone
WIND
Direction and Relative Velocity
hours
19–24 9–19 0–9
RAIN
mm.
150 100 50 0

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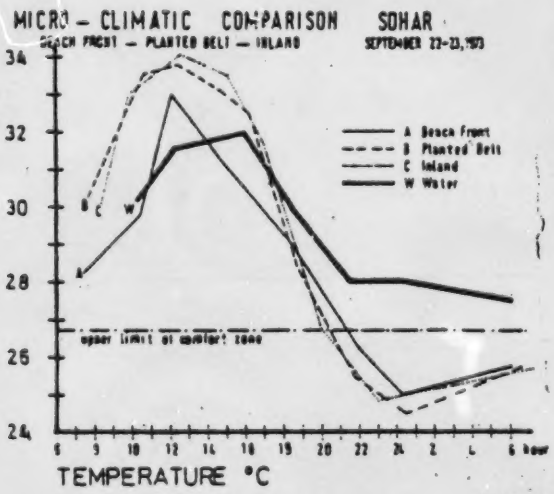
Fig A4 MICRO CLIMATIC COMPARISON

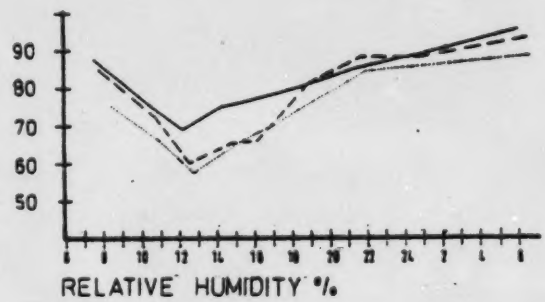
Plan of Sohar showing test sites

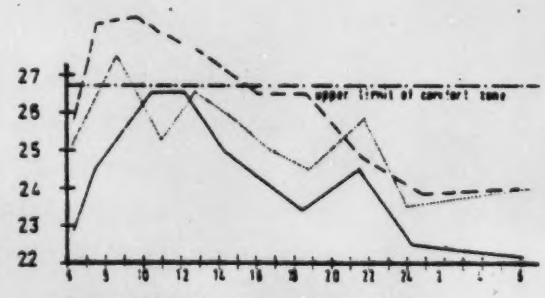
Day time — sea breeze.

Night time — land breeze.



WIND





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c) They provide security, to possessions. d) They control the amount and quality of light entering the room. During the daytime, when external light is bright and the level of glare is high, one's focus falls naturally upon the screen; to look outside would be uncomfortable. As the lighting level drops outside (early morning and evening) the external light becomes more comfortable and one can look through the screen to the outside.

These screens combine the functions of window, wall and air conditioner in a way that is cheap and simple but effective. (Fig. A.5)

Many of the houses also make use of windcatchers to induce more air movement into rooms below. (Fig. A.6) On the Batinah Coast these are made with a wooden framework, supporting panels of hessian sackcloth. When the temperature is cool enough for additional air movement to be unnecessary, the hessian is removed and the opening to the room closed off.

In winter, temperatures are cool, and most beach front houses have a winter half to match the summer quarters. The winter half has rooms made of mud brick, which keeps air movement out, (unwanted in winter) and by its thermal mass, retains warmth which is radiated to the interior. (Fig. A.7)

3.3 Houses in the date gardens.

The range of temperature between night and day is greater here than on the beach, but houses still need air movement, particularly in the daytime for comfort. Walls and roofs are usually made of palm frond stem screens, but there are a variety of types, different ones used in different spaces to meet the specific requirements of each room.

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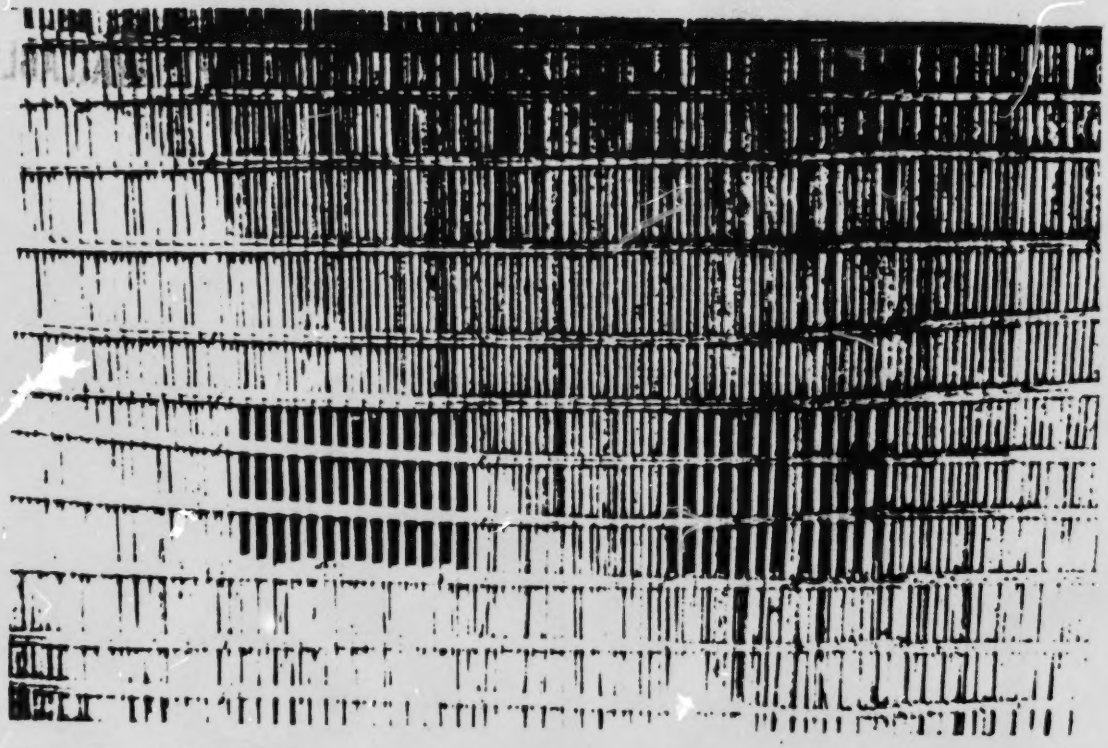

FigA5 EXTERNAL VIEW OF PALM FROND SCREEN

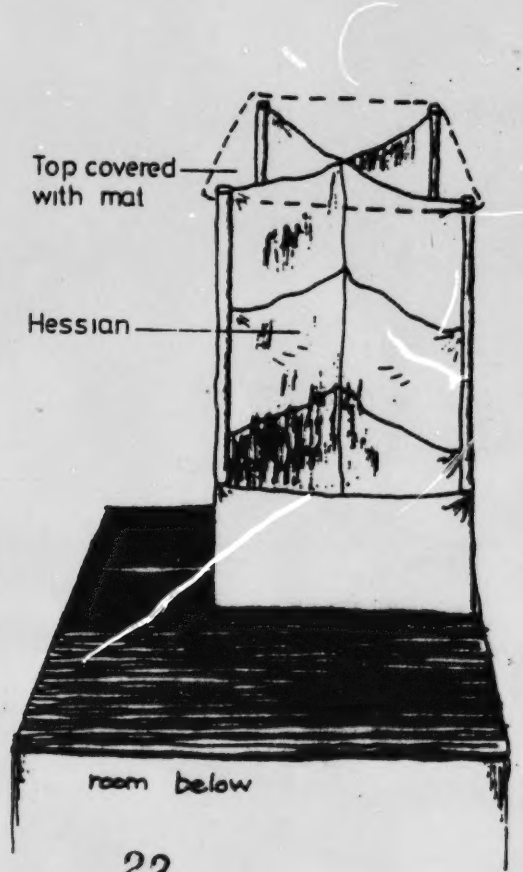

Fig A6 HESSIAN WINDCATCH

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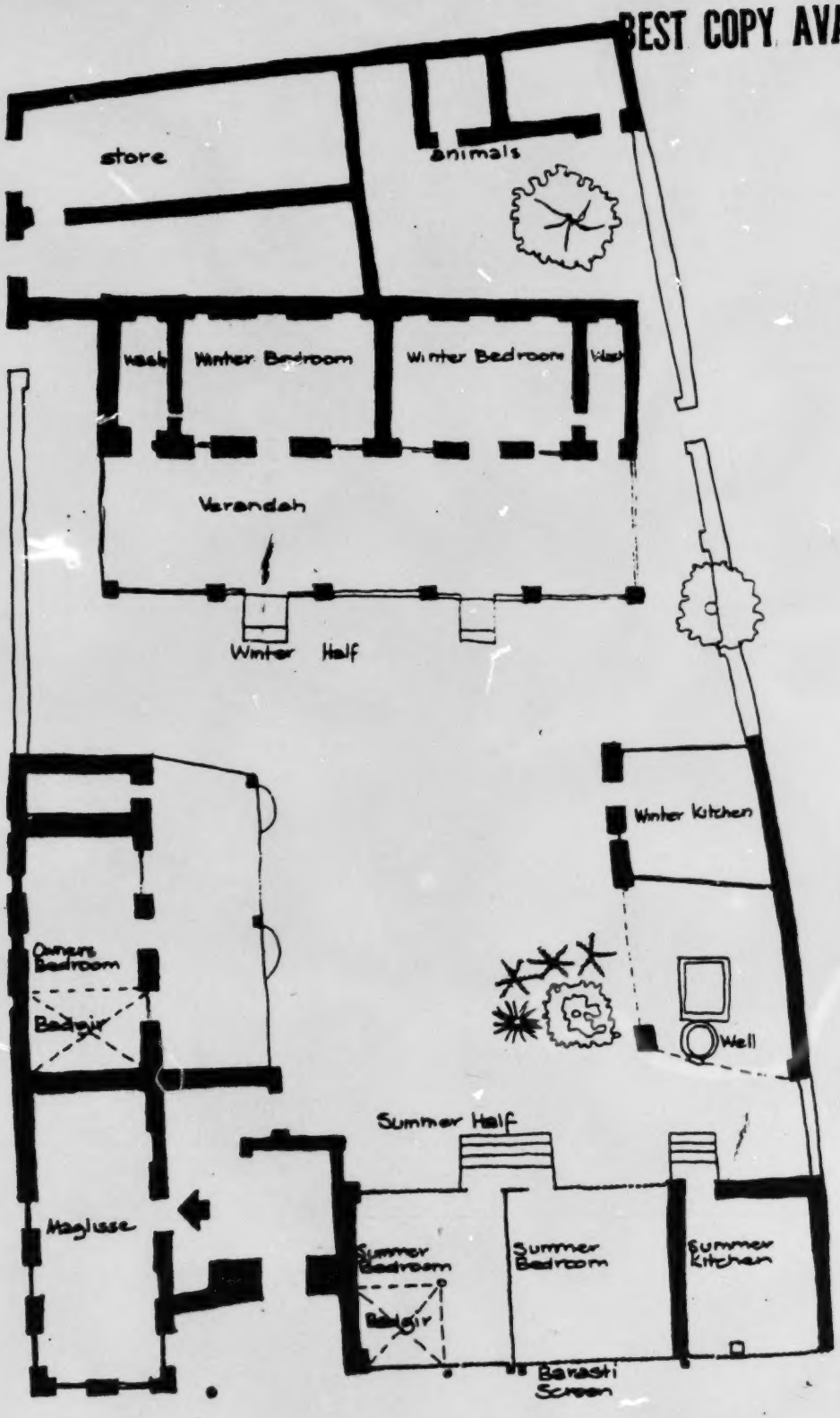

HOUSE OF MOH'D SHERIF ABDULLAH
BEACH - SOHAR

Fig A7

Summer daytime spaces often have no walls facing the prevailing breeze, but are shaded and protected at the side. The positioning of screens allows for privacy. Screens are also added or removed according to seasonal variation of climate. Screens used in bedrooms are made of palm frond stems with the leaves retained, to provide insulation, and in many houses a double layer of stems is used to form a sandwich panel with leaves compressed in the middle, particularly for autumn and winter sleeping rooms. A room will often have different panels on each wall, one to let in light and air movement during the day, another to protect the room from wind blowing at night, which comes from inland. (Fig. A.8)
Wind catches are not used in this belt.

3.4 Inland of the planted belt.
Here the daily and seasonal range of temperature is much greater and the relative humidity less. Air movement through the building is less desirable; instead, a material which will balance the extremes of daytime heat and nighttime coolness is required. Most of the houses here are built of mud/mud brick, which has the ability to store daytime heat and transmit it to the interior during the night. The interior rooms remain at a constant temperature.

Because many of the people living here work during the summer in the date gardens, some of the inland settlements are used only in the winter, with migration into the date gardens to houses built with palm frond stems during the summer.

3.5 Conclusion
Each location has a particular micro climate, any single solution will be unsuitable for all three locations. The

Fig A8 HOUSE IN OM EL BOCHE

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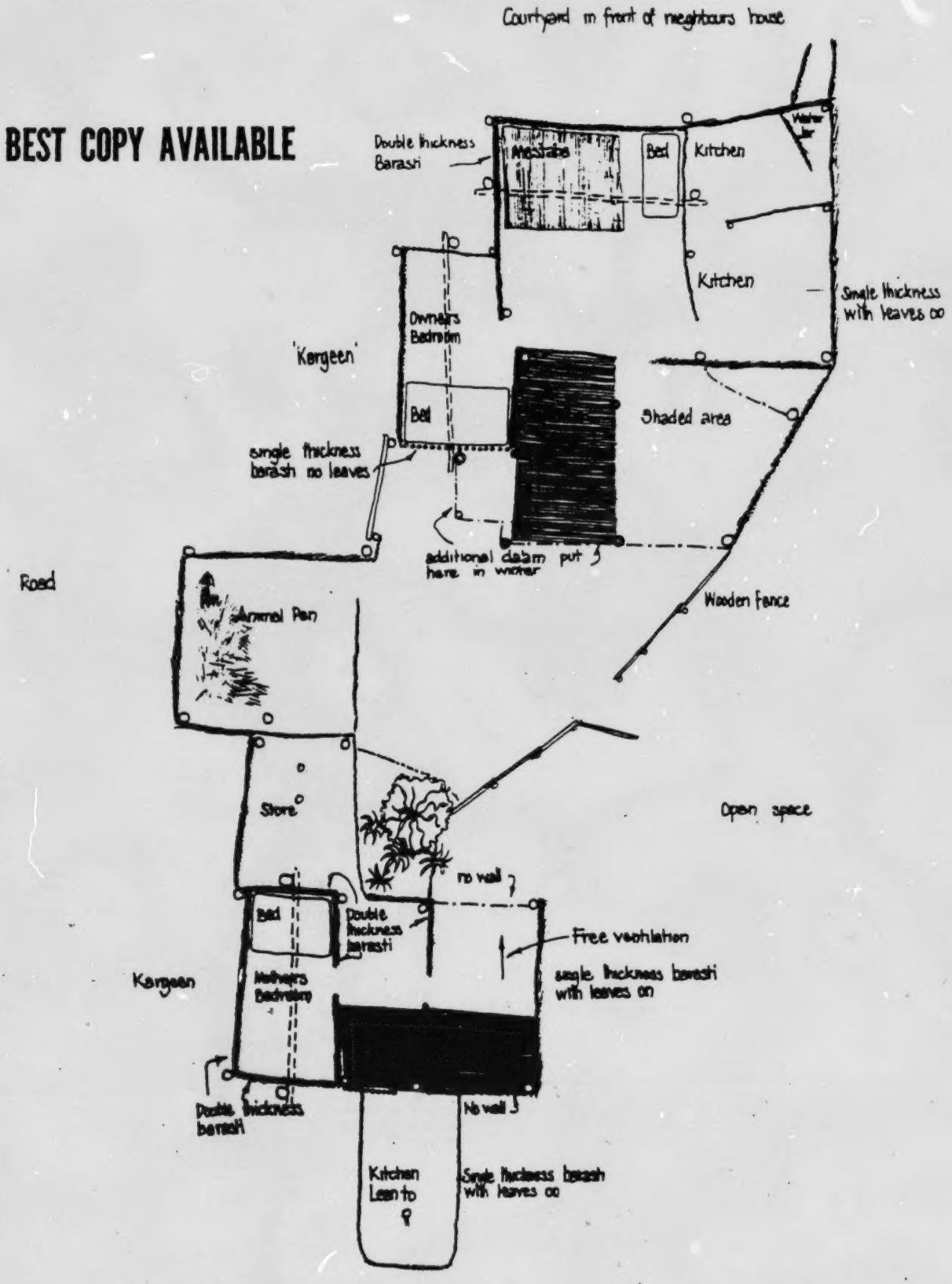

Floor Plan

Barasti house - Salem Ben Abdullah - Om el Boche Wilaya of Sohar

materials used for building houses in each location are used differently in response to the immediate condition and to what is immediately available.

Recent trends towards using concrete block and sheet metal for building has negated much of the response to local conditions, and owners of houses using these new materials admit that they are less comfortable.

3.6 Materials

The palm frond stems used in this area are criticised on several points. They are attacked by termites and have to be replaced after a few years. They are liable to catch fire, and they accumulate dust and insects.

Various experiments and tests were conducted with palm frond stems after the field work, as well as comparisons with alternative available materials.

The problem of termites (mainly subterranean termites) can be overcome by careful design. Equally, by careful design and selective use of materials in fire risk areas, including the introduction of fire retardant solutions, the risk of fire can be reduced.

After comparison with concrete block buildings in the area, it was found that the palm frond stem houses did not contain significantly more dust or insects than the concrete block houses.

It was suggested that the local materials had a) a useful potential role to play in meeting the shelter needs of the area, in a way that was cheap and socially and environmentally appropriate and that b) much could be learnt from the way in which the indigenous houses were built and lived in.

4 THE NORTHERN UPLANDS

4.1 Introduction

A mountain range separates the Batinah Coast from the interior desert of Oman. The principle area of habitation is the central valley lying at the foot of the Jebel Akhdar. This valley narrows from the South East, where it opens onto the desert, towards the North West. Nizwa, the largest town, used to be the capital of Oman. As with most of the settlements in the area, Nizwa is surrounded by date gardens. The settlement stands on land not usable for agriculture, and due to limited space, is compactly laid out.

Because of the altitude and the distance from the sea, the humidity is less than on the coast, and annual and diurnal temperature ranges are greater. However, from May to August temperatures exceed the comfort zone, and from November to February temperatures are too cold. (Fig. A.9)

Many families move out from the town into summer houses in the date gardens for comfort during the hottest time of the year.

4.2 House form

Whilst there are considerable local variations, there is a basic housing and settlement pattern in this area. Houses are predominantly built with mud brick. The dense clustering of houses and the use of mud results in a built environment that maintains a high thermal capacity, levelling out the extremes of temperature and producing moderate internal temperatures. Town houses are built on a central courtyard form, and are usually two or three storeys high. The courtyard serves as a light and ventilation shaft to the lower floors. The deep courtyards ensure that privacy is maintained and

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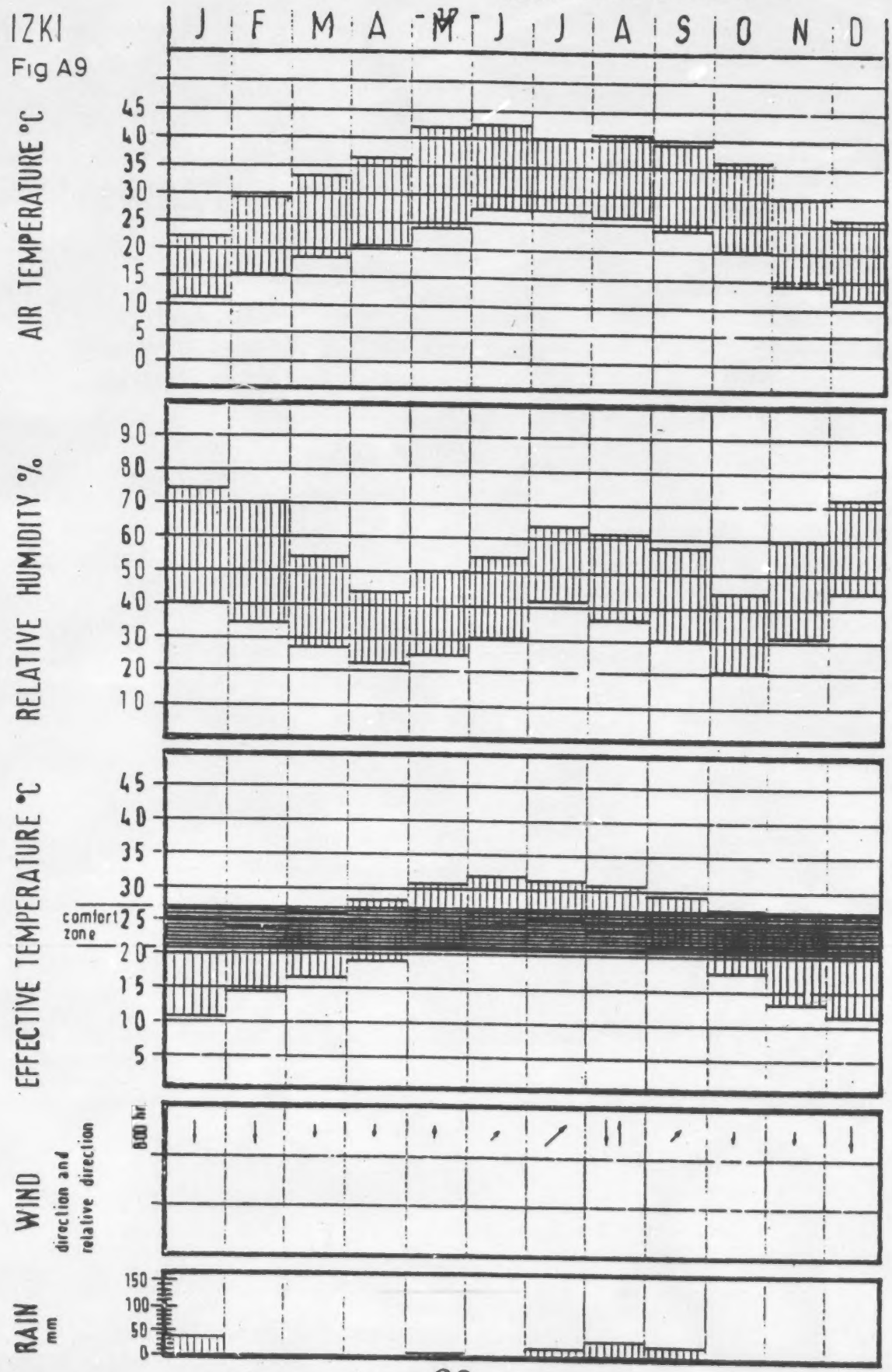
IZKI

Fig A9


J F M A M J J A S O N D
AIR TEMPERATURE °C
45 40 35 30 25 20 15 10 5 0
RELATIVE HUMIDITY %
90 80 70 60 50 40 30 20 10
EFFECTIVE TEMPERATURE °C
45 40 35 30 25 20 15 10 5
comfort zone
WIND
direction and relative direction
800 hr
RAIN
mm
150 100 50 0

high parapet walls are put up where there might be a view overlooking a neighbour. The courtyard also acts as a temperature regulator, storing heavy cool night-time air at the bottom of the courtyard, which then helps to keep the building cool during the hot daytime. Lowest rooms are often used for storage, with lighter and airier rooms higher up the building. As with the Batinah Coast, certain rooms are set aside for use at different times of the year. Windows are larger at the top and small or non-existant near the ground. One room, essential to all houses in the area, occurs at the ground floor. This is the room for entertaining guests (the Maglisse) and is a feature also found on the Northern Coast. In the Northern Uplands this room is also used as a workshop, and is often the only room with an outward looking aspect in houses which are almost entirely inward looking, especially at lower levels. (Fig. A.10)

Recent changes have introduced concrete as a building material, which is extremely expensive by comparison to mud. Its thermal performance can be compared to mud brick in (Fig. A.11), whicn shows that the concrete wall transfers extremes of temperature quickly to the interior. A change to more outwardlooking housing set apart from neighbouring houses has also increased the amount of direct solar gain on walls and through windows.

4.3 Conclusion

The indigenous courtyard house is climatically and socially well suited to the local conditions. Mud brick is also climatically and economically appropriate. Its main drawbacks are the need for periodic maintenance and the increasing attitude that is inferior as a material to concrete block. A new house in Izki, completed in 1973 had been built entirely with concrete, but in exactly the

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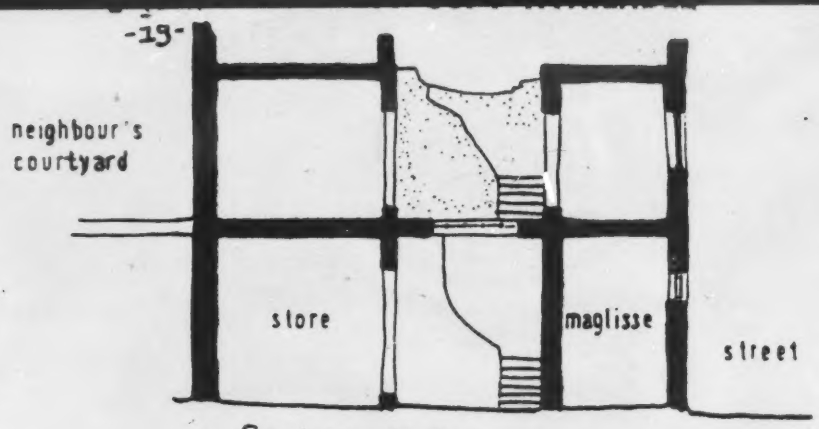
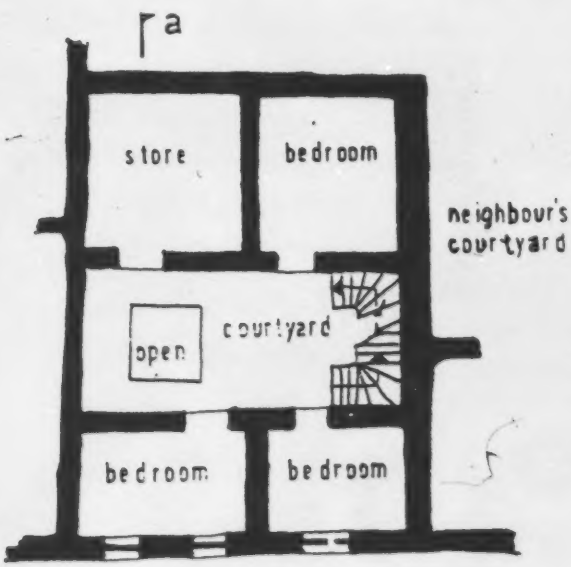
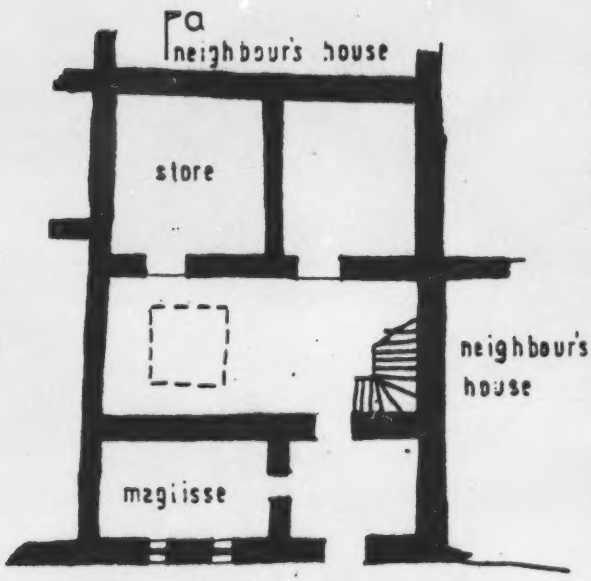


Section a a

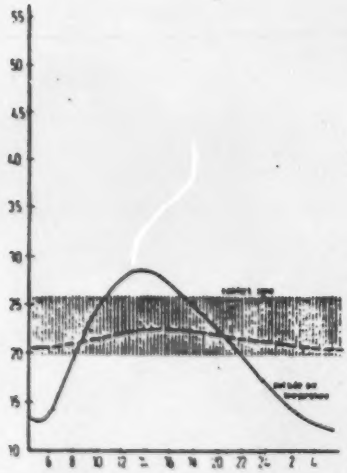
Fig A 10
TOWN HOUSE IN NIZWA



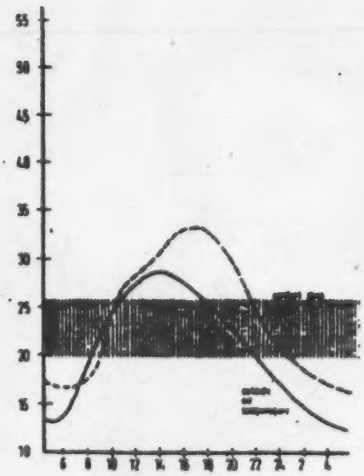
First floor plan
a



Ground floor plan
a



Mud brick room.
Interior air temperature – – –



Prefab concrete room.
Interior air temperature – – –

Fig A 11
COMPARISON
BETWEEN
THERMAL
PROPERTIES OF
MUD & CONCRETE

same form and with walls of a thickness required with mud brick. The owner had borrowed money to finance the building, and had amassed debts that would be transferred to his children. His motivation for this move to concrete was to reinstate his local prestige, which had been damaged in tribal skirmishes several years previously.

5 DESERT OASIS - BURAIMI

5.1 Introduction

Buraimi is one of several oases on the border between Oman, Abu Dhabi and Saudi Arabia. Its climate is primarily that of the hot dry desert, but it is modified by a) winds blowing from the sea, which bring rain occasionally, and b) by the more humid mild climate of the oases itself, induced by moisture in the soil and plants. Although there is a distinct hot and cold season and a wide diurnal range, the temperatures are not as extreme as the hot dry desert climate. There are seasonal prevailing winds which are stronger in winter than in summer. (Fig. A.12)

As with the settlements in the Northern Uplands the shortage of water ensures that land suitable for agriculture is little used for building, although there are a few houses within the oasis. The main settlement sits at the edge of the date gardens, on land which does not have water for irrigation, but sited as close as possible to the planted areas, to benefit from the more comfortable conditions.

5.2 House form and materials

Houses have traditionally been built of mud brick and are similar to those of the Northern Uplands, with a limited use of palm frond stems in roofing. Recently, corrugated iron and concrete block have been introduced, particularly into the market area. These produce extremely unsatisfactory shelters, especially where the temperatures are high. Corrugated iron transfers the outside surface temperature immediately to the interior, inducing a build up of heat inside which is well in excess of any concievable comfort level. Many of these shelters were used (1973) to keep and sell food in, particularly in the meat market. Because of the high temperatures this was extremely unhealthy.

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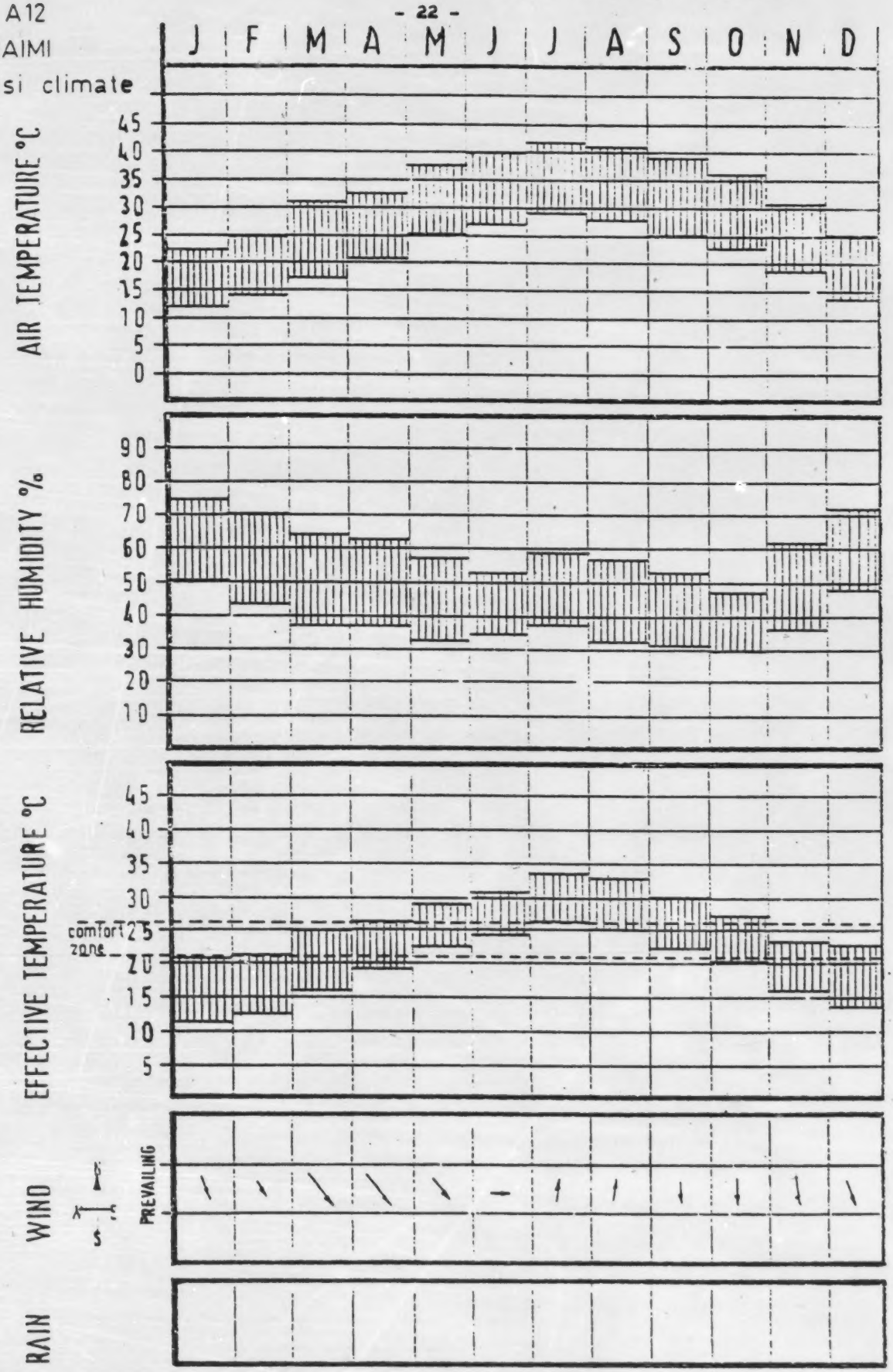
Fig A12
BURAIMI
oasisi climate



6 THE CAPITAL REGION : MUSCAT, MUTRAH, RUNI

6.1 Introduction

This region is bounded by the sea to the north east, the Batinah Coast to the north west, and is otherwise surrounded by bare mountains. Muscat itself is completely hemmed in by mountains. The division between this area and the Batinah comes at the point where the date gardens are replaced by bare limestone hills.

The climate is characterised by consistantly high temperatures and relative humidity, there is little change between night and day. Muscat has an especially harsh climate, since heat is re radiated from the surrounding rock mountain sides which enclose the town, pushing the temperature up an additional 5°C. The critical months for cooling are between April and October. (Fig. A.13)

Muscat has traditionally been a major power centre, and has in consequence more large houses than Mutrah, which still serves as the main commercial centre, with a largely middle class population, many of whom are from India and Pakistan and form the main merchant community. Mutrah is more densely built upon than Muscat, but Muscat has no room for expansion and in 1973 there were signs that some of the old buildings were being replaced. Recent expansion has taken place in the Ruwi valley behind Mutrah, and most new housing, ministries and embassies are situated here. They are characteristic of the sort of building and planning taking place in the area. One would normally expect to find a relatively scattered settlement pattern to respond to the climatic conditions in Muscat and Mutrah, but population pressures have made this impractical.

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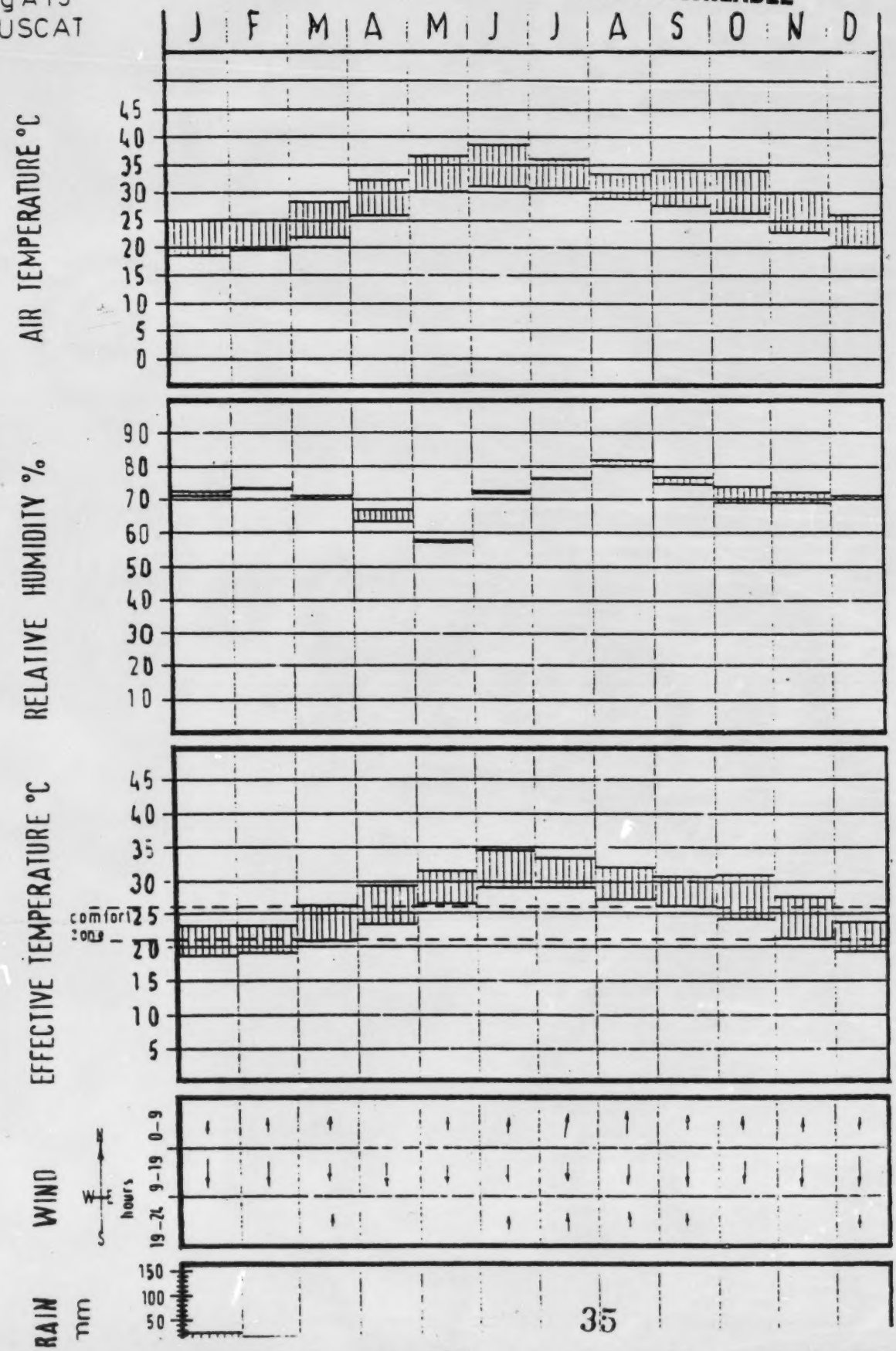
Fig A 13
MUSCAT


J F M A M J J A S O N D
AIR TEMPERATURE °C
45 40 35 30 25 20 15 10 5 0
RELATIVE HUMIDITY %
90 80 70 60 50 40 30 20 10
EFFECTIVE TEMPERATURE °C
45 40 35 30 25 20 15 10 5
comfort zone
WIND
N W S
hours
0-9 9-19 19-24
RAIN
mm
150 100 50

6.2 House form

The houses of Muscat and Mutrah are traditionally based upon a courtyard plan, where shade and privacy are available and where any cool air can be trapped and help to cool the rest of the building. The walls were usually of limestone, retaining any internal coolness. Upper floor rooms, which are the main living and sleeping spaces, have large windows facing both the sea and the courtyard, to allow any available air movement to pass through rooms. The windows are often of elaborate design, allowing air to enter the room when it is advantageous but excluding solar radiation which would raise indoor temperatures. Because of the air's moisture content the sky reflects a great deal of light and skies are much brighter than one would find in drier regions. Because of the glare problem of bright skies the high windows opening to the sky are generally of latice work. Openings high up in rooms are also necessary to allow for the escape of warm air which collects in the upper reaches of a room due to convection. (Fig. A.14)

6.3 Conclusion

New houses in the area rely almost entirely upon air conditioning to combat the external climatic conditions; the use of courtyards and properly designed windows can greatly improve the natural performance of the house, most especially in terms of the quality of light and restriction of glare. The model of new housing in the area is furthermore being adopted by people who cannot afford the expensive mechanical means to readjust the unfavourable internal climate that is created when buildings are designed without considering the alternative means already available for creating comfortable internal conditions.

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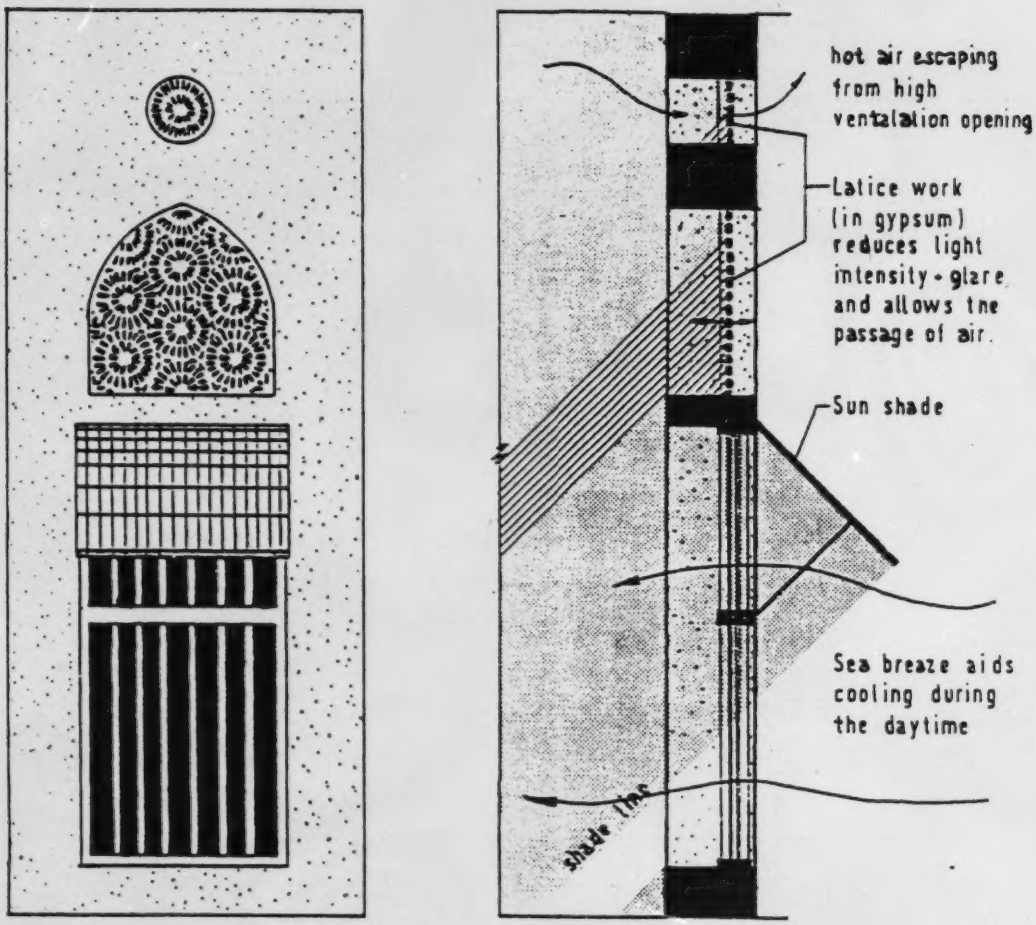
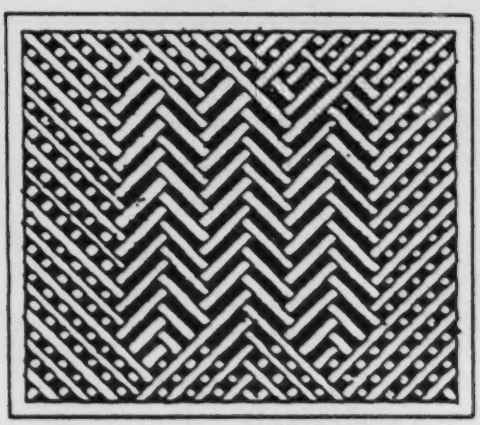
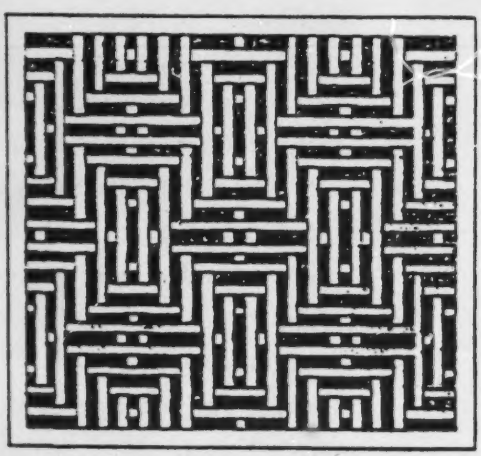
Fig A 14


hot air escaping from high ventalation opening
Latice work (in gypsum) reduces light intensity - glare and allows the passage of air.
Sun shade
Sea breaze aids cooling during the daytime
shade line
Elevation
Section

Window Details - from Najwani House - Mutrah bay front
(Multi-Level Openings) showing function of latice work and ventalation system.





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Latice Windows - from houses in Muscat town centre.
Made of small wooden pieces each having a square section, fixed by peg connections.

7 SUR

7.1 Introduction

Sur lies at the far north eastern corner of Oman, at the point where the Persian Gulf enters the Indian Ocean, and has developed as a strategic and trading port. It is in decline now. Its trade has dropped off as other routes have developed and the building of traditional dhows is less in demand than in the past. There is high unemployment and many of the workers have migrated to the gulf states in search of employment.

The town of Sur lies on a peninsula, almost entirely surrounded by water, a lagoon inland and the sea on the other side. The town is densely built up on the permanent dry land separating these two. Some houses rise to 2 or 3 storeys.

Sur is uncomfortably warm between May and September, but for the rest of the year has a comfortable to slightly cool climate, Relative humidity is always high, with a peak during the summer. Because of its position on the coast the town experiences daytime onshore breezes and nighttime offshore breezes for most of the year, with a modified pattern during the middle of the winter, due to prevailing winds from the North, and at the height of the summer, a southerly land breeze which negates the daytime sea breezes and reduces air movement at the most uncomfortable time of day. (Fig. A.15)

The settlement pattern of the town helps to compensate for this lack of breeze. The compact streets remain in shade for most of the day, and air is cooler here than in the public and private open spaces, where direct solar radiation heats up the air and causes it to rise. This air is replaced with cooler air from the shady streets, and in this way air movement is induced.

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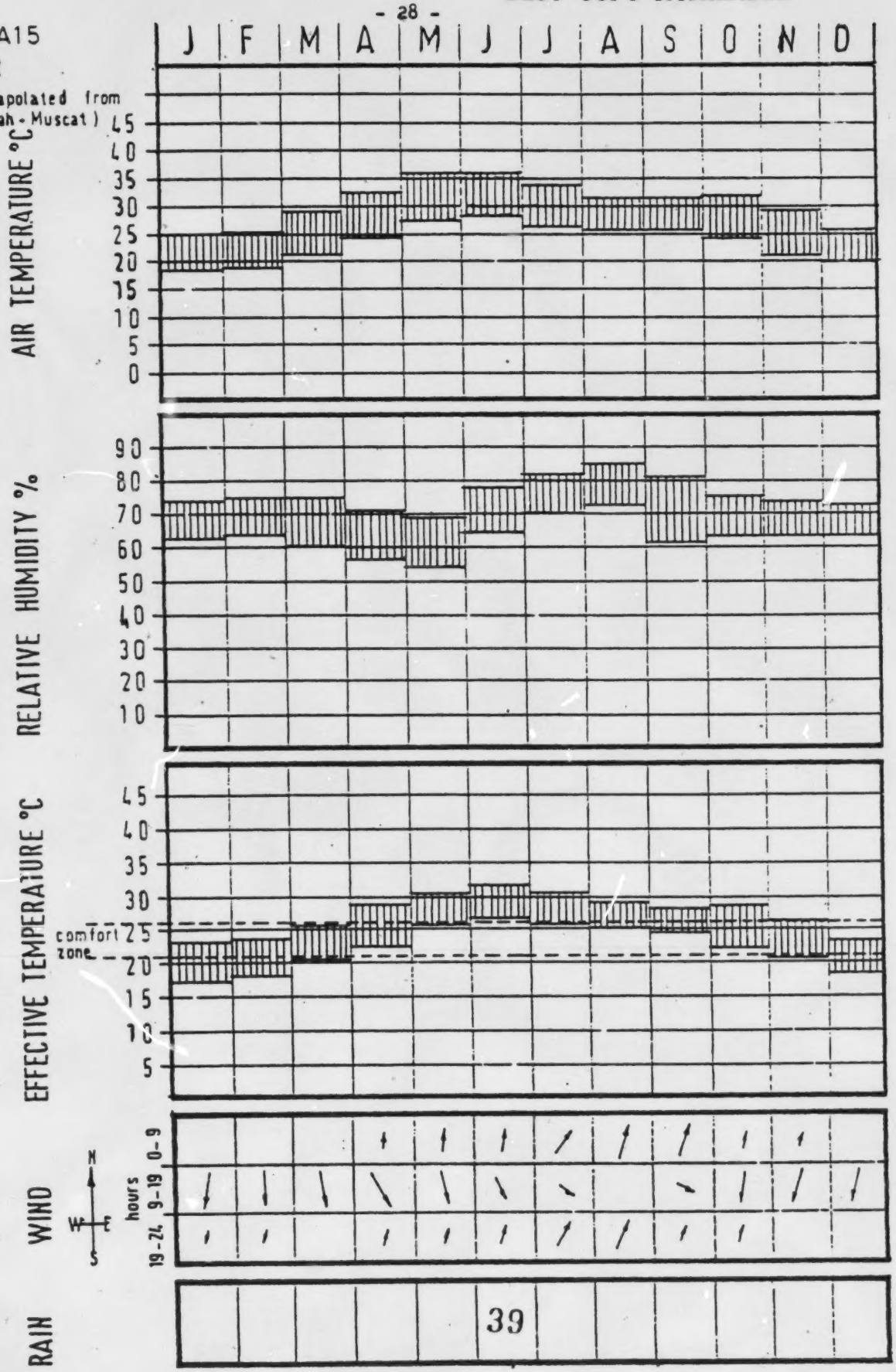
Fig A15
SUR
(extrapolated from Mazirah - Muscat)


J F M A M J J A S O N D
AIR TEMPERATURE °C
45 40 35 30 25 20 15 10 5 0
RELATIVE HUMIDITY %
90 80 70 60 50 40 30 20 10
EFFECTIVE TEMPERATURE °C
45 40 35 30 comfort 25 zone 20 15 10 5
WIND
N W E S
hours
19-24 9-19 0-9
RAIN

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7.2 House form

The courtyard house is the dominant house from of the area. These houses usually start with one room and a 2.5 metre high perimeter wall encompassing the site. As demand and finance permit, the house grows, first by adding rooms at ground floor level and then moving up to the first and sometimes second floor. (Fig. A.16)

Older houses are made of limestone. Newer houses are made of concrete block but based upon the same plan form. Because of the density, privacy is important and houses are inward looking, and where there are openings facing outwards they have carefully arranged screens which restrict a view over a neighbour's property. There is an extremely strong social consciousness about a neighbour's privacy. Rooms where possible are concentrated on the south side of the courtyard, to allow as much air movement to enter after passing across the unobstructed courtyard to the seaward side of the rooms. This serves to slightly overcome the restriction to air movement resulting from the dense town plan.

Windows are mainly in higher rooms, but are placed low enough so that the breeze will pass through the room at floor sitting height. Louvres are used to encourage the air to flow in the right direction. Windows are placed on opposing walls to allow a cross flow through the room. (Fig. A.17)

Some houses are built with palm frond stems, but this is usually a transitional stage before building more substantial rooms.

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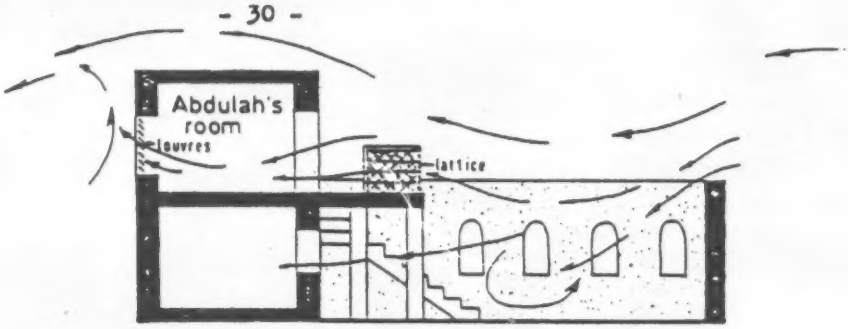
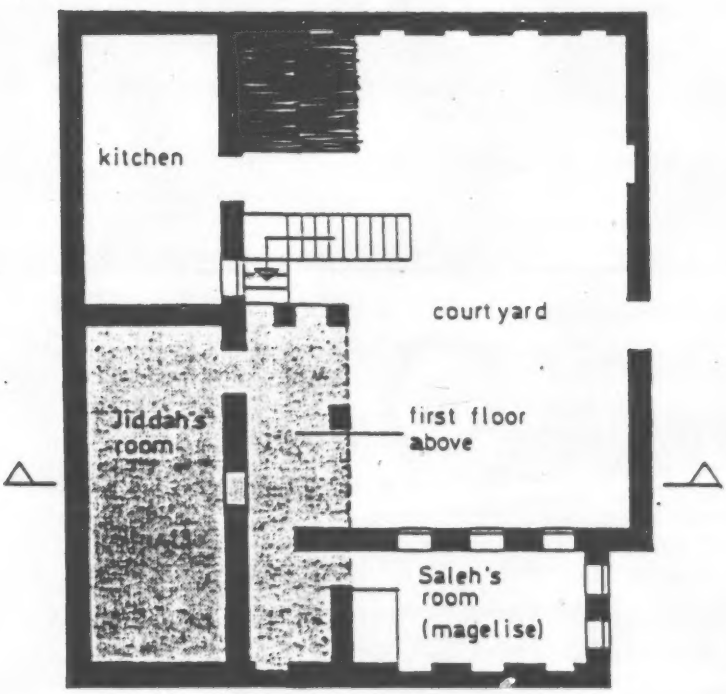


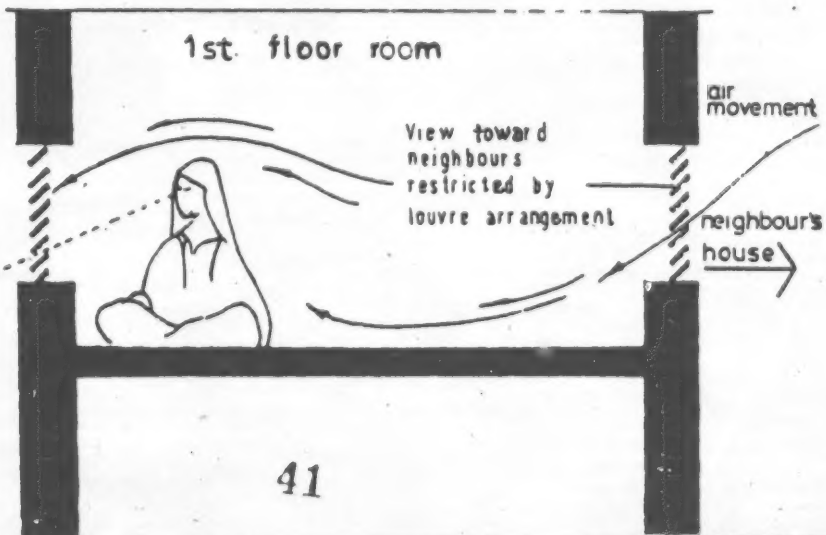
Section
showing air movement



Ground Floor Plan

Fig A16
House of three brothers.
SUR

Fig A 17
AIR MOVEMENT



7.3 Conclusion

Two features in Sur which will hopefully remain in continued use are the courtyard and the positioning and design of windows. They are both simple means to ensure privacy whilst encouraging air movement into dwelling spaces. In 1973 there had been little outside influence in terms of building styles and new houses were being developed to make full use of these principles. Such an approach was to be encouraged where mechanical means of cooling are both expensive and not readily available.

8 DHOFAR COAST (SALALA)

8.1 Introduction

The inhabited section of the Dhofar coastal plain is mainly focused upon Salala. The town lies 4 - 5 kms to the south of the Dhofar hills which are green with trees and grass during the rainy season. Salala itself has numerous coconut palm groves supported in the past by the 'Falaj' system of irrigation and by tapping the water table where the limestone bedrock has been dug away to allow trees to root.

There is considerable building activity due to immigration of people into town.

Previously Salala's economy was very dependant on its fishing industry, with a strong trading link with the people in the hills, who used the fish to feed their cattle, which were traded in return. This trade has largely died out and Salala now imports most of its requirements.

Salala technically lies within the Warm Humid Tropical Zone and is often regarded as being monsoonal, although the monsoon's affect is one of extremely high humidity (95%) during the summer but more mist and slight drizzle than proper rainfall. The annual rainfall is in fact low (80 mm per annum). Climatically critical times of year are between May and June and again in October, but throughout the summer air movement is important for cooling. (Fig. A.18)

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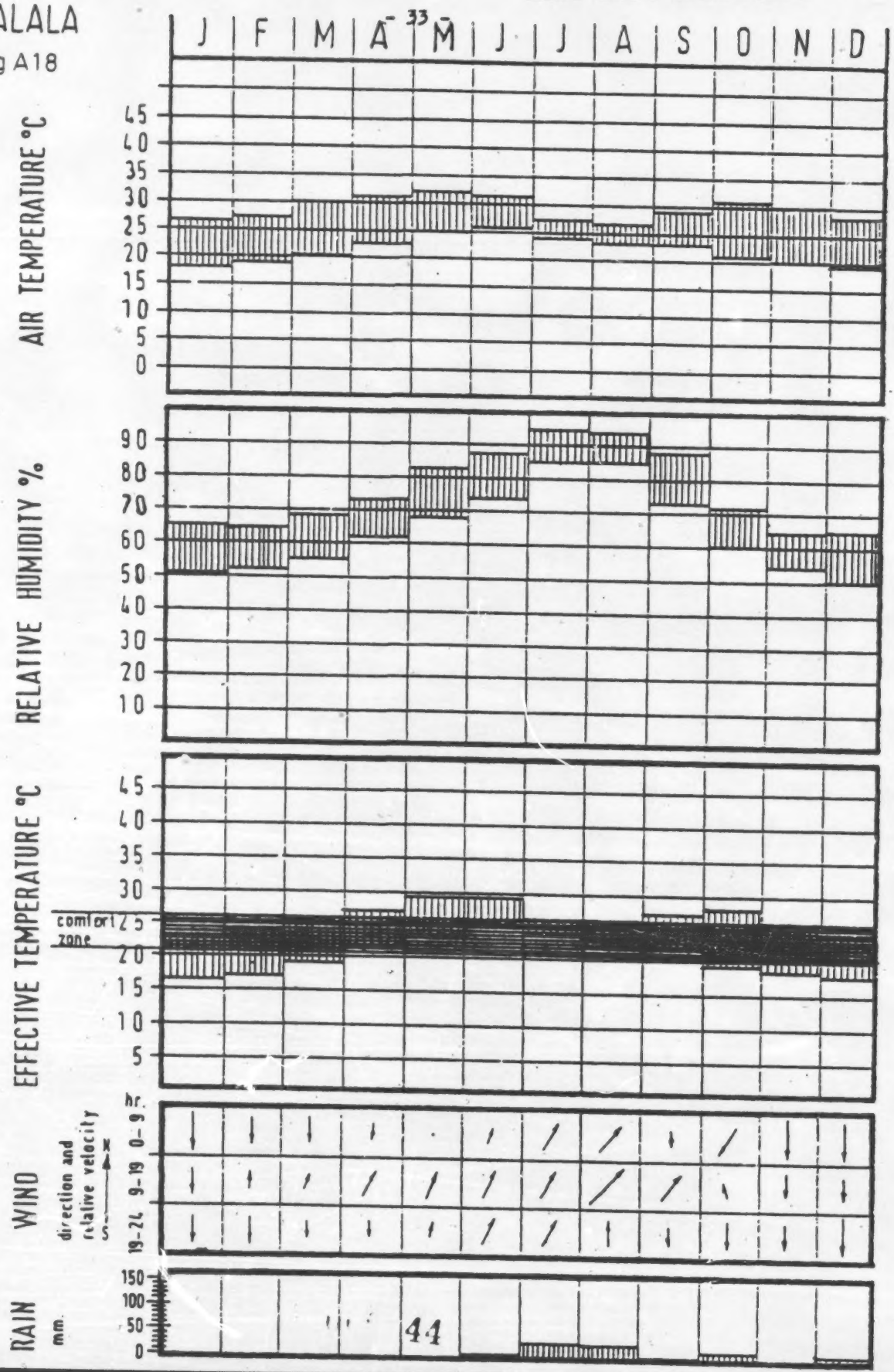
SALALA

Fig A18



8.2 Settlement Pattern

The layout of the town is responsive to the need for air movement. Houses are set well apart from each other, aligned parallel to the sea. Houses are situated not only to accept the maximum breeze (diurnal on-shore/off-shore breezes and prevailing south/Westerly winds in summer) without blocking the passage of air movement to the houses behind. Where two houses are in line with the breeze, there is sufficient space between the houses for the air movement pattern to return to normal, i.e., the second house lies beyond the wind shadow of the first house. (Fig. A.19)

A prominent feature of Salala houses is the large yard in the southern front of the house, defined by a low perimeter wall. This land belongs to the house owner and ensures that no one else builds too close.

The new arrivals into town are increasing the density in newer parts of the town, but wherever possible new house builders adhere to the same principles of orientation and spacing.

8.3 House form and materials

Houses on the beach front, lived in mainly by fishermen, are of palm frond stems collected on site from the coconut groves. These houses allow fee air movement during summer. Some rooms are plastered with mud and are used in winter, when thermal and insulation is desirable. The summer rooms of palm frond stems are well suited to the beach front sites, where relative humidity is at its highest.

Inland from the beach front and the palm tree belt are more substantial houses of limestone belonging primarily

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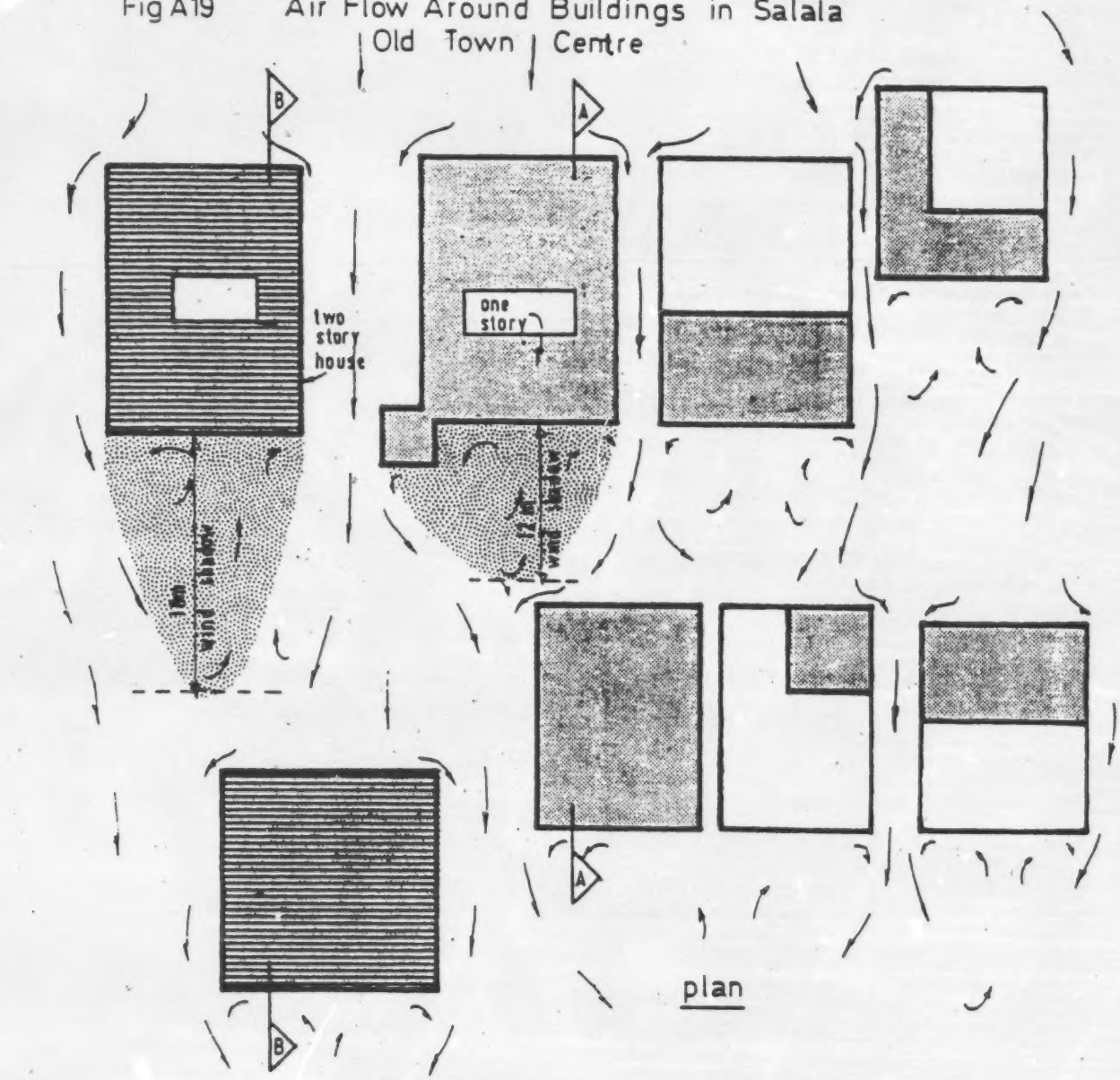
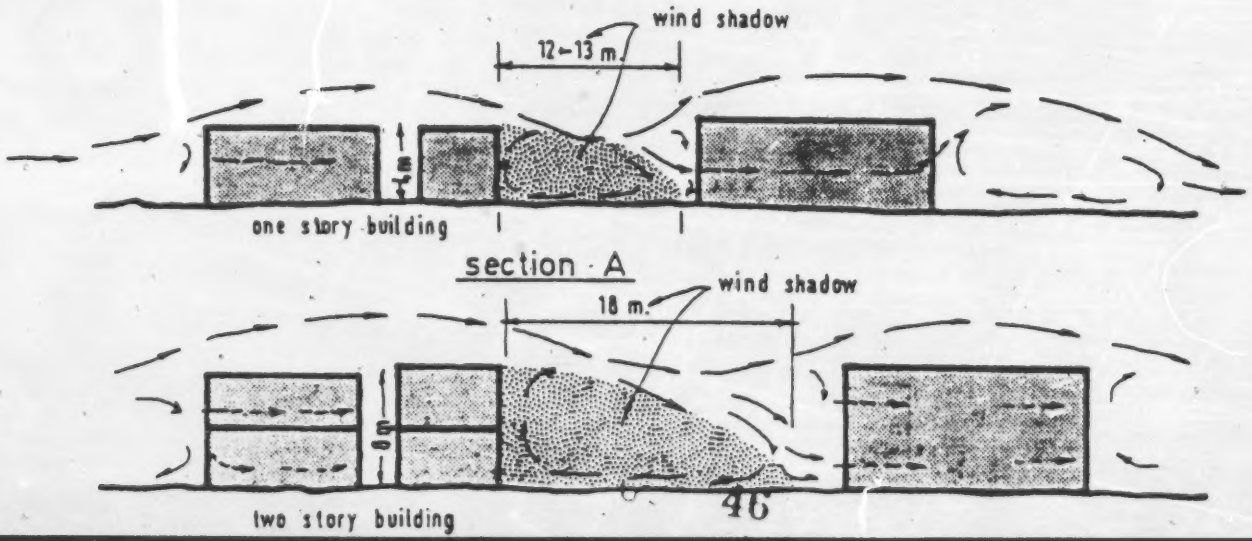
Fig A19 Air Flow Around Buildings in Salala Old Town Centre





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to the merchants of Salala. New houses are built of limestone or concrete block.

The thick limestone walls transfer heat quite slowly having a high thermal capacity. This means that heat from direct solar radiation does not reach the interior until about 18 hours later. Mid day heating will thus be entering the house at about 6 a.m. the following morning, when the interior is coolest. This thermal capacity is more important during the winter when temperatures drop below the comfort level.

The houses are all built around a courtyard. Older houses rise to 3 or 4 storeys, and the courtyard is a cool shady space where any colder air will be trapped and used to cool the adjacent rooms. At the hottest time of day the rooms will be noticably cooler than the external air temperature.

Cement blocks which are coming into widespread use are cheaper than limestone (1973 price 22 Omani Rials per 100 cement blocks as opposed to 30 Omani Rials/100 limestone blocks). However the limestone blocks are larger and have a better thermal performance. The preference was for limestone where finance permitted.

The production of limestone blocks had scope for improvement. With the exception of one imported stone cutting machine which produced very little and was inefficient, all limestone blocks were quarried by hand. Whilst this was a major source of employment, the blocks were irregular in size and production slow. The introduction of some machinery on a co-operative basis to help these people was suggested.

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The process of housing allowed for the use of more expensive materials. Houses developed room by room, influenced by the size of the family and the money available. New refugee housing was following the same pattern, with the initial room being of palm frond stems or canvas, whilst a more substantial room was developing on the same site. This process was greatly assisted by the local official policy of giving security of land tenure to new arrivals, who could then develop their plot of land as their own situation permitted, rather than having to achieve the whole house at one stage. (Fig. A.20)

8.4 Conclusion

The social responsiveness towards neighbours in the lay-out of the town was excellent. New planned housing tended to ignore many of the simple requirements for providing a healthy and comfortable and socially responsive environment. Salala also illustrated how, through a gradual process of house building, an insubstantial start, using palm frond stems, can be developed into sophisticated permanent housing which responds to the family needs and capabilities in a manner that cannot be achieved by housing provided for families without their participation over the years. It was noted that limestone was also favoured because it could be more easily re-used for new room arrangements than cement block.

Fig A20 EVOLUTION OF COURTYARD HOUSE
SALALA

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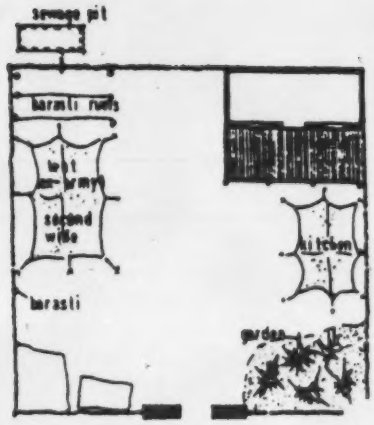
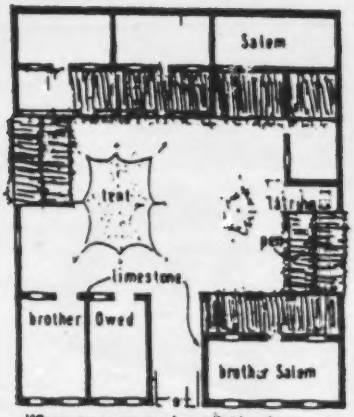
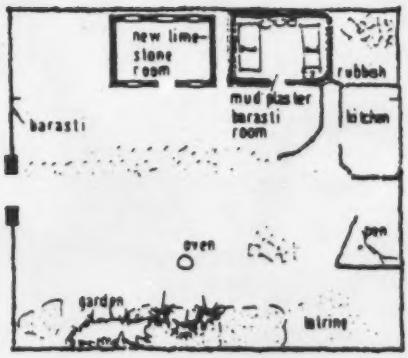
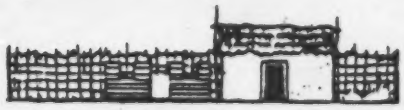


A low income family would first establish a perimeter wall and install a temporary shelter. This may be a tent or a palm frond stem room.

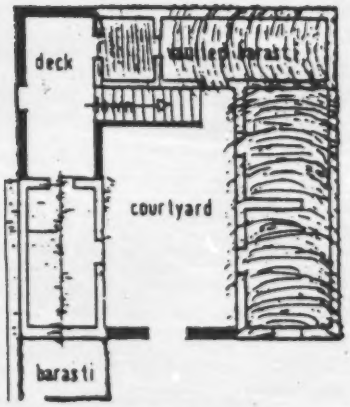


When more money is available, the temporary rooms are replaced, using a more durable material such as limestone, with a view to supporting a second floor in the future.

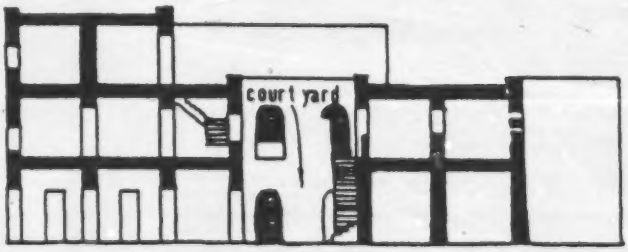




The palm frond stem room is later plastered with mud to form a more permanent shelter.



Once the ground floor rooms are completed in load bearing materials, rooms are built following the same pattern on the first floor. (2 storey house in limestone with vaulted 'barasti' roofing.)



The house thus grown in a spiral manner until a substantial house develops. (3 storey limestone house in old town centre of Salala)

9 OVERALL CONCLUSION

From the study of the 6 regions, it became clear that:

a) No one unified type of building could realistically be applied to the whole country. Unfortunately there was evidence in 1973 that a unified approach was being taken, with identical new buildings occuring in different areas.

b) The local materials and techniques were capable of meeting many of the local requirements. In the process, their use enabled the house owner to adapt his house to suit his needs. The use of local materials and skills also helped to generate and stimulate the local economy. New projects tended to employ foreign labour and skills and materials. New skills were not being learnt and old ones were being forgotten.

c) In most regions visited, the indigenous building methods were capable of providing comfortable and healthy living conditions. The indigenous building methods suffer most from being associated with underdevelopment and the notion that they are inferior to newly introduced 'solutions'. In all areas visited, local inhabitants voluntarily explained how their indigenous houses functioned and how they provided for comfort. Prestige was the one major factor that was inducing the change from the traditional pattern.

d) For the country to genuinely attempt to meet the building and other needs that it faced, the population had to participate to ensure that there would be a balanced distribution of facilities and opportunities. There were insufficient resources and skills and capital to allow development to take place relying primarily upon imported technologies and materials. Local resources needed to be used and could benefit the economic and social development of each area. The use of new and imported techniques should be applied selectively where they were really needed, and not as an overall approach, destroying the existing fabric of the country.